CHAPTER I 1- INTRODUCTION 1.1- Refractories Refractories are traditional ceramic materials that can afford high-temperatures without deterioration .Table 4.Most common additives in refractory castables Function Additive Accelerator Retarder pH control Water Reducer Rheology Modifier Lithium carbonate X Calcium hydroxide X X Sodium carbonate X X Sodium bicarbonate X Sodium citrate X X X Sodium phosphate X X X Sodium polyacrylate X X Polycarboxylate X X Citric acid X Boric acid XRefractory brick Refractory monolithic Uniformity More uniform because they do not contain cement and fired at high temperatures with out using anchors [Innovations reference] Less uniform and is used by using anchors Flexibility More flexible due to more lining joints Less flexible Ease of use Labor intensive which Requires time and highly skilled technicians Simple and less time consuming but carful curing is required Pore size Pore size ranges from 20-25 microns Micro porous structure with pore diameter 1-2 um Strength and thermal shock resistance Low strength and TSR due to relatively large pore diameter size High strength and TSR due to small pore diameter Thermal conductivity Higher thermal conductivity Lower thermal conductivity due to lower radiation heat transfer through small pore size Corrosion resistance Low corrosion resistance Higher corrosion resistance Deformability Less flexible More flexible especially phosphate-bonded castables Dimensional stability More stable as it is a fired product Less stable due to shrinkage during firing in the installation place 1.2.2 Refractory Castables Monolithic materials were first used in 1914 when as simple mixture of crushed firebrick and fireclay was produced (Shubin, et al., 2001).Common modifiers used in refractry castables Filler/Modifier Chemical formula Function Fine milled aggregates Various Chemistry, Mineralogy and adjustment, bond modification and development Calcined alumina ?- Al2O3 Chemistry adjustment, bond modification and development Reactive alumina ?- Al2O3 Flow/rheology control, bond modification and development Silica quartz SiO2 Shrinkage control Kyanite 3 Al2O3.3SiO2 Shrinkage control (1325-1410 C), chemistry and mineralogy adjustment Clay Hydrated alumino-silicate Filler, flow/rheology control Zircon ZrSiO4 Reduce metal, slag, attack Graphite/Carbon C Reduce metal, slag attack Graphite/Carbon C Reduce metal, slag attack Fly ash Varies Low-temperature filler The properties of the castables which includes expansion control, bond enhancement, and mineralogy/chemistry adjustment can be controlled by using additives or admixtures in small amounts ranging from 0.05-0.5 wt. % (Bartha, et al., 1999) .The different mineralogical forms (individually or in combination) of oxides such as alumina (Al2O3), calcium oxide (CaO), silica (SiO2), magnesium oxide (MgO), zirconium dioxide (ZrO2), chromium oxide (Cr2O3), and carbon (C) are the most suitable and widely used materials in the refractories applications (Sengupta, 2020).Some of these materials are unsuitable to be used as refractories on the industrial scale due to their fast reaction with atmospheric moisture, such as calcium carbide (CaC2), barium oxide (BaO), and aluminum carbide (Al4C3) or their high costs such as molybdenum (Mo), niobium (Nb), vanadium (V), and hafnium (Hf).e. Corundum refractories: it consists from a single phase (polycrystalline alpha alumina) with alumina more than 99 wt.% f. Magnesite refractories: they are basic in nature with magnesium oxide as a basic constituent at least 85 wt. % g. Dolomite refractories: It is a double carbonate mineral of calcium and magnesium when fired transferred to oxides, usually contains less than 2.5 impurities and greater than 97.7% (CaO + MgO).White fused alumina (WFA) is manufactured by the fusion process of Calcined alumina in an electric arc furnace and its microstructure is

characterized by corundum grains while brown fused alumina (BFA) is produced by bauxite fusion with higher impurities compared to WFA.Cement free castables then developed with further higher refractoriness due to the very low calcium oxide where they have superior corrosion resistance towards metals and slags but have lower physical and mechanical properties compared to LCCs and ULCCs (Javed, et al., 2004) .Table 2.Refractory Castables composition Aggregates 40–80 % Modifiers 5–30 % Bond agents 2–50 % Admixtures CaO >1.0, ultra–low cement (ULLC) where 1.0 %CaO0.2%, and no cement castables (NCC) where CaO